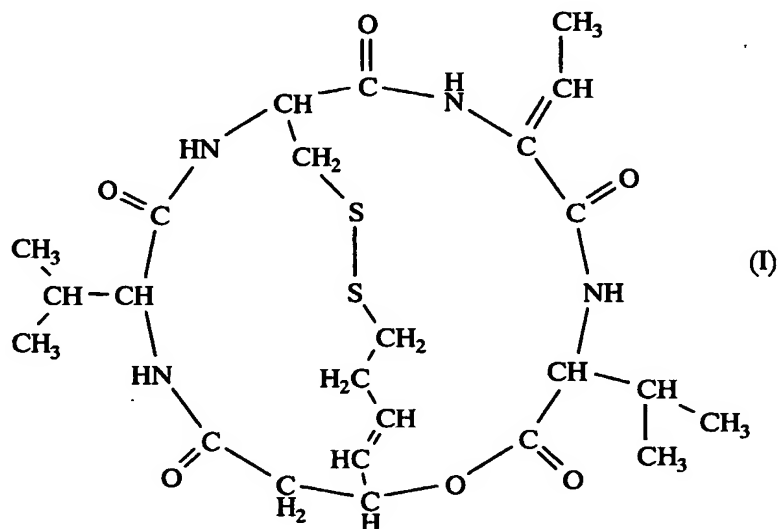


10 Rec'd POT/PTC 05 OCT 2004

Technical field

Background Art

15 For example, it has been reported that a compound
 (Sequence Listing SEQ ID NO. 1) of the formula (I)



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(JP-B-7-64872, H. Nakajima et al., Exp. Cell Res. 241, 126-133 (1998)). As the situation stands, however, there are many problems yet to be solved, such as effectiveness of *in vitro* results in *in vivo* application, *in vivo* effectiveness against
5 any tumor and the like. The antitumor activity *in vitro* against kidney cancer has been reported, but an antitumor activity *in vivo* against kidney cancer has not been reported.

Histone deacetylase is a metallo deacetylase having Zn coordinated at the active center (M.S. Finnin et al., Nature,
10 401, 188-193 (1999)). This enzyme is considered to change affinity of various acetylated histones for DNA. The direct biological phenomenon provided thereby is a change in the chromatin structure. The minimum unit of the chromatin structure is a nucleosome wherein a 146 bp DNA winds around a
15 histone octamer (H2A, H2B, H3 and H4, 2 molecules each, core histone) 1.8 times counterclockwise. The core histone stabilizes the nucleosome structure as the positive charge of the N-terminal of each histone protein interacts with DNA. The acetylation of histone is controlled by the equilibrium
20 relationship between acetylation reaction, in which histone acetyltransferase is involved, and the deacetylation reaction, in which histone deacetylase is involved. The acetylation of histone occurs in an evolutionarily well-conserved lysin residue in the N-terminal of a histone protein, whereby, it is
25 considered, the core histone protein loses the charge of the N-terminal, the interaction with DNA decreases, and the structure of nucleosome is instabilized. Conversely, therefore, deacetylation of histone is considered to stabilize the nucleosome structure. However, the degree of changes in the
30 chromatin structure caused by the acetylation is unclear nor is it clear how it is related to the secondarily induced control of transcription.

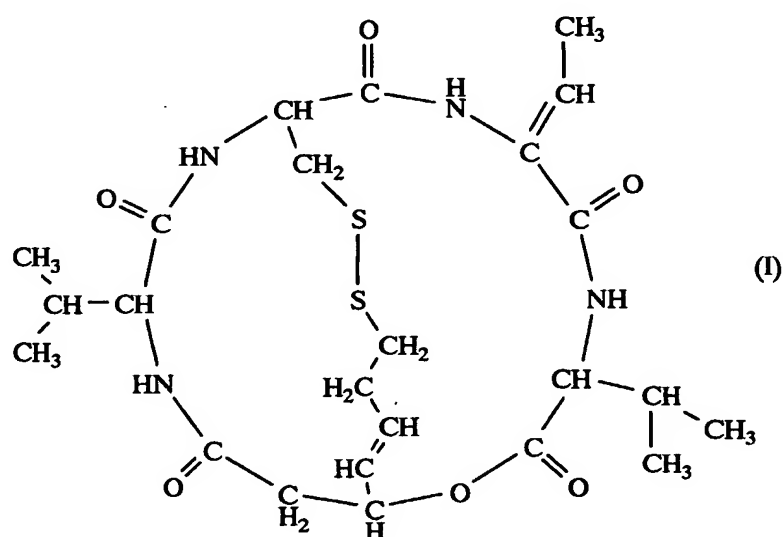
Disclosure of The Invention

The present inventors have conducted intensive studies

in an attempt to solve the above-mentioned problems, and found a therapeutic agent for kidney cancer, which is capable of confirming its antitumor effect *in vivo*, particularly in human patients with kidney cancer, which resulted in the completion
5 of the present invention.

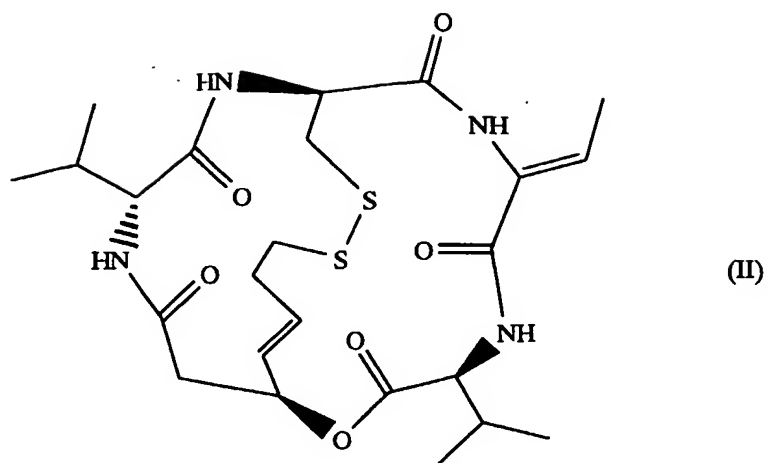
Accordingly, the present invention provides the following.

(1) A method of treating kidney cancer in mammals, which comprises administering an effective amount of a compound of
10 the formula (I)



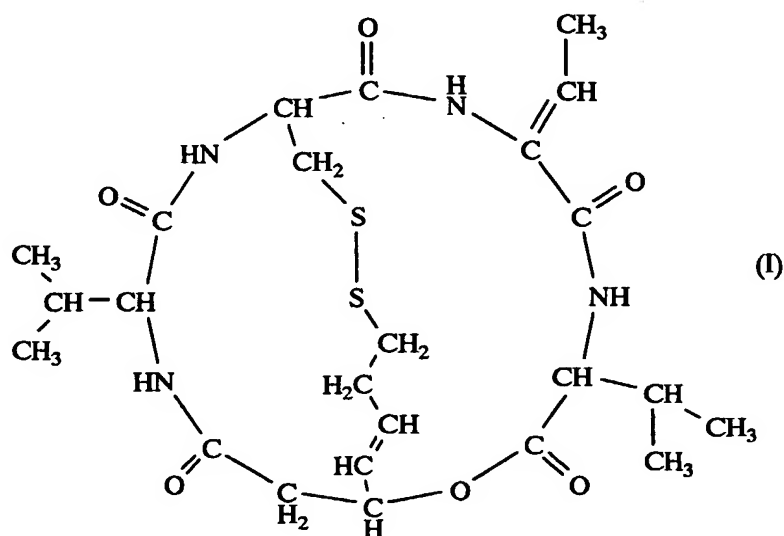
or a salt thereof to a mammal.

(2) The treatment method of kidney cancer according to the above-mentioned (1), wherein the compound of the formula (I) is
15 a compound of the formula (II)



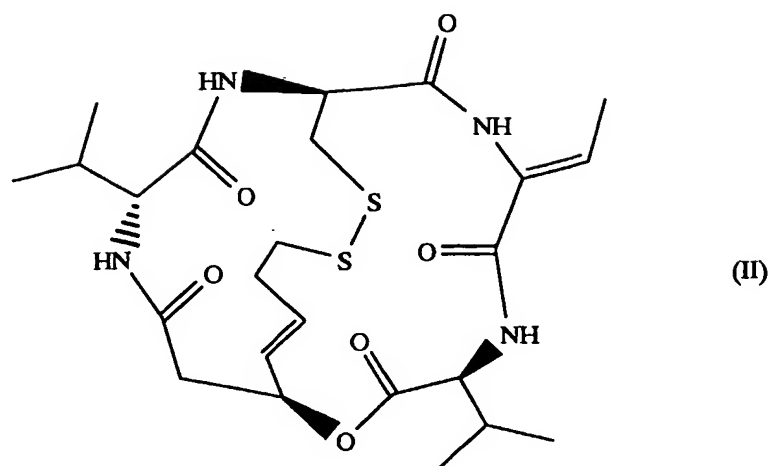
(3) The treatment method of kidney cancer according to the above-mentioned (1), wherein the mammal is a human.

(4) A method of suppressing growth of a cancerous tumor of the kidney in mammals, which comprises administering an effective amount of a compound of the formula (I)



or a salt thereof to a mammal.

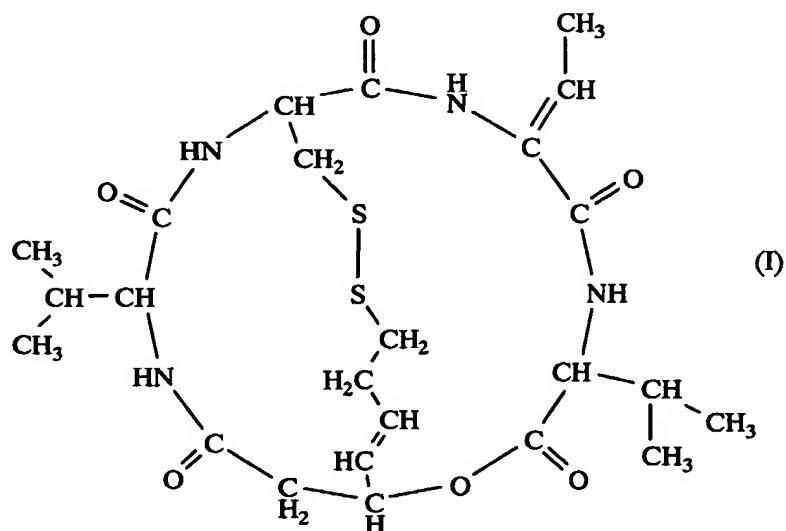
(5) The method of suppressing growth of the cancerous tumor of the kidney according to the above-mentioned (4), wherein the compound of the formula (I) is a compound of the formula (II)



(6) The method of the above-mentioned (4) for suppressing the growth of the cancerous tumor of the kidney *in vivo*.

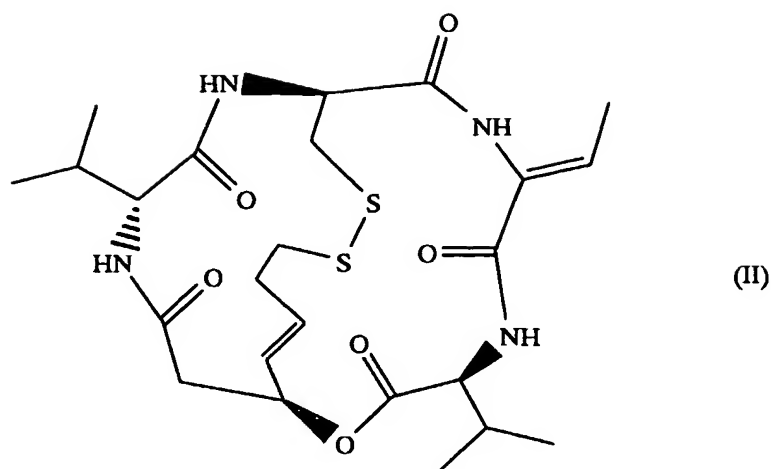
(7) The method of the above-mentioned (6), wherein the *in vivo* means in a body of a human.

(8) A therapeutic agent of kidney cancer, which comprises, as an active ingredient, a compound of the formula (I)



or a salt thereof.

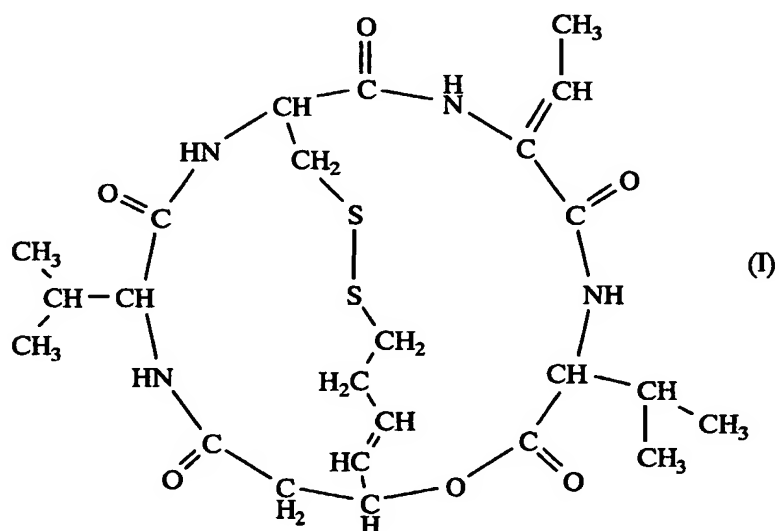
(9) The therapeutic agent according to the above-mentioned (8), wherein the compound of the formula (I) is a compound of the formula (II)



(10) The therapeutic agent according to the above-mentioned (8), which has an antitumor activity *in vivo*.

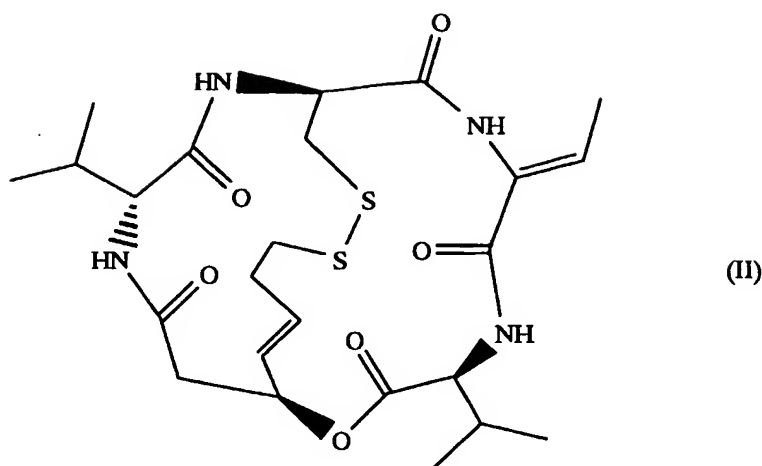
(11) The therapeutic agent according to the above-mentioned
5 (8), which is used for a human.

(12) Use of a compound of the formula (I)



or a salt thereof, for the production of a therapeutic agent of kidney cancer.

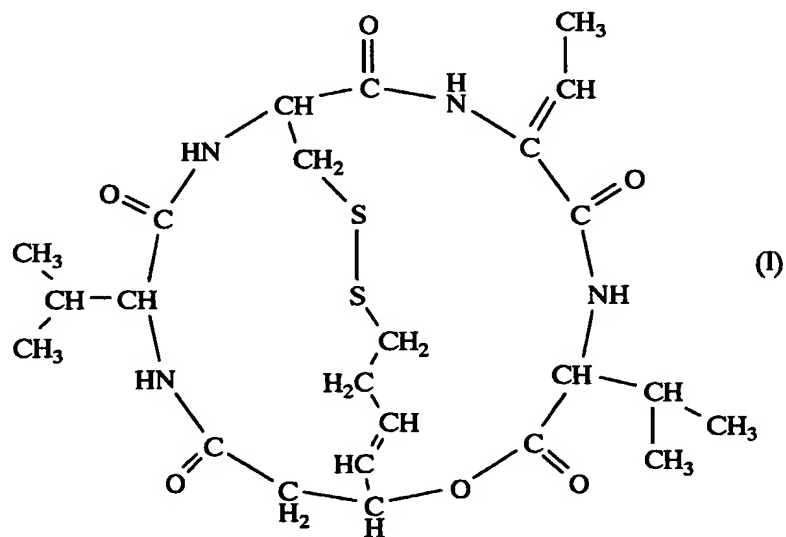
10 (13) The use according to the above-mentioned (12), wherein the compound of the formula (I) is a compound of the formula (II)



(14) The use according to the above-mentioned (12), wherein the above-mentioned therapeutic agent of kidney cancer has an antitumor activity *in vivo*.

5 (15) The use according to the above-mentioned (12), wherein the above-mentioned therapeutic agent of kidney cancer is used for a human.

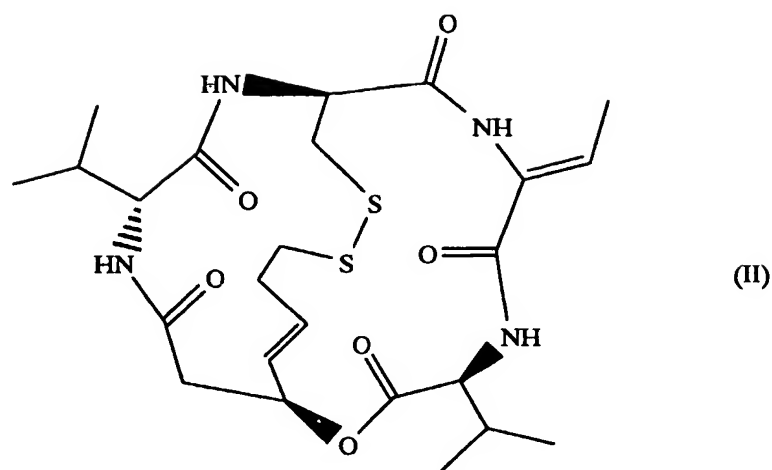
(16) A pharmaceutical composition for treating kidney cancer, which comprises a compound of the formula (I)



10

or a salt thereof, and a pharmaceutically acceptable carrier.

(17) The pharmaceutical composition of the above-mentioned (16), wherein the compound of the formula (I) is a compound of the formula (II)



(18) The pharmaceutical composition of the above-mentioned (16), which has an antitumor activity *in vivo*.

(19) The pharmaceutical composition of the above-mentioned (16), which is used for a human.

(20) A commercial package comprising a pharmaceutical composition of any of the above-mentioned (16) to (19) and a written matter associated therewith, the written matter stating that the pharmaceutical composition can or should be used for treating kidney cancer.

Brief Description Of The Drawing

Fig. 1 is a graph showing the antitumor activity of FR901228 against human kidney tumor (RXF-631L) transplanted in mouse.

Detailed Description Of The Invention

The therapeutic agent of kidney cancer of the present invention contains, as an active ingredient, a compound of the formula (I) (hereinafter to be also referred to as FK228) or a salt thereof. The treatment method of kidney cancer of the present invention includes administering an effective amount of FK228 to mammals inclusive of human. Of the compounds of the formula (I), preferred is a compound of the formula (II), which is a stereoisomer (hereinafter to be also referred to as FR901228). These compounds have a potent histone deacetylase inhibitory activity (Nakajima, H. et al.; *ibid* (1998)), and

particularly FR901228 has an even more potent histone deacetylase inhibitory activity. Therefore, it is suitably included in the therapeutic agent of kidney cancer of the present invention, and can be suitably used for the treatment
5 method of kidney cancer of the present invention.

Unless otherwise specified, a simple reference to FK228 in the present specification means a group of compounds, irrespective of the stereoisomerism, including a compound of the formula (II).

10 FK228 and a salt thereof are known substances and are obtainable. For example, FR901228, which is one of the stereoisomers of FK228, can be obtained by culturing, under aerobic conditions, a bacterial strain belonging to the genus *Cromobacterium*, which is capable of producing FR901228, and
15 recovering the substance from the culture broth. The bacterial strain belonging to the genus *Cromobacterium*, which is capable of producing FR901228, is exemplified by *Cromobacterium violaceum* WB968 (FERM BP-1968). An FR901228 substance can be obtained from this production cell according to the disclosure
20 of JP-B-7-64872. It is preferable to obtain FR901228 from a bacterial strain belonging to the genus *Cromobacterium*, which is capable of producing FR901228, because FR901228 can be obtained more easily. However, synthetic or semi-synthetic FR901228 is also advantageous because an additional
25 purification step is not necessary or can be made simple. Similarly, FK228 other than FR901228 can be synthesized or semi-synthesized by a method conventionally known. To be specific, it can be produced according to the method reported by Khan W. Li, et al. (J. Am. Chem. Soc., vol. 118, 7237-7238
30 (1996)).

The salt of FK228 is a biologically acceptable salt, which is generally non-toxic, and is exemplified by salts with base or acid addition salts, inclusive of salts with inorganic base such as alkali metal salt (e.g., sodium salt, potassium

salt etc.), alkaline earth metal salt (e.g., calcium salt, magnesium salt etc.), ammonium salt, salts with organic base such as organic amine salt (e.g., triethylamine salt, diisopropylethylamine salt, pyridine salt, picoline salt, 5 ethanolamine salt, triethanolamine salt, dicyclohexylamine salt, N,N'-dibenzylethylenediamine salt etc.), inorganic acid addition salt (e.g., hydrochloride, hydrobromide, sulfate, phosphate etc.), organic carboxylic • sulfonic acid addition salt (e.g., formate, acetate, trifluoroacetate, maleate, 10 tartrate, fumarate, methanesulfonate, benzenesulfonate, toluenesulfonate etc.), salt with basic or acidic amino acid (e.g., arginine, aspartic acid, glutamic acid etc.), and the like.

FK228 has stereoisomers based on asymmetric carbon atom 15 and double bond, such as optical isomer, geometric isomer and the like, all of which and mixtures thereof are also encompassed in the present invention.

Further, solvate compounds (e.g., inclusion compound such as hydrate etc.) of FK228, FR901228 and salts thereof are also 20 encompassed in the present invention.

In the present invention, *in vivo* and *in vitro* means as these terms are used in this field. That is, "*in vivo*" means that the target biological functions and responses are expressed in the body, such as in the body of various mammals 25 to be mentioned below, preferably in the body of a human. The term "*in vitro*" means that such functions and responses are expressed in test tubes including tissue culture system, cell culture system, cell free system and the like.

FK228, which is a histone deacetylase inhibitor, exerts 30 an antitumor activity against various tumors. Among others, it shows a noticeable effect *in vivo* and in human against kidney cancer.

The therapeutic agent of kidney cancer of the present invention can be used for mammals such as human, dog, bovine,

horse, rat, guinea pig and the like.

The therapeutic agent of kidney cancer of the present invention can be used in the form of a solid, semi-solid or liquid pharmaceutical preparation containing FK228 or a salt thereof as an active ingredient in admixture with an organic or inorganic carrier or excipient suitable for oral or parenteral application. The active ingredient can be admixed with a typical, non-toxic pharmaceutically acceptable carrier suitable for the dosage form, such as powder, tablet, pellet, capsule, suppository, liquid, emulsion, suspension, aerosol, spray and other form for use. Where necessary, auxiliary agent, stabilizer, tackifier and the like may be used. These carriers and excipients may be sterilized where necessary, or a sterilization treatment may be applied after formulation into a preparation. FK228 and a salt thereof are contained in the therapeutic agent of kidney cancer in an amount sufficient to produce a therapeutic effect on kidney cancer, such as suppression of infiltration into surrounding tissues, metastasis to a distal part, and growth of cancer.

The method of administering the therapeutic agent of kidney cancer of the present invention is free of any particular limitation as long as it can provide a therapeutic effect on kidney cancer described above. Particularly when the therapeutic agent of kidney cancer of the present invention is used, parenteral administration is preferable, namely, intravenous administration, intramuscular administration, direct administration into the tissue, administration into nostril cavity, intradermal administration, administration into cerebrospinal fluid, administration into biliary tract, intravaginal administration and the like. In addition, a liposome method and the like can be preferably used. When this therapeutic agent is applied to a human, intravenous administration, intramuscular administration or oral administration is preferably employed for the application. A

therapeutically effective amount of the active ingredient, FK228 or a salt thereof, varies depending on the age and condition of individual patients to be treated, and the type of cancer. In the case of intravenous administration, the daily
5 dose of FK228 is generally 0.1-100 mg, preferably 1-50 mg, more preferably 5-30 mg, per m² of the body surface area of human, which is continuously administered by infusion to treat the tumor. The time of continuous administration by infusion varies depending on the dose. It is preferably 3-6 h, more
10 preferably 3.5-4.5 h, most preferably 4 h. The administration frequency is based on a cycle containing 1 to 4 times of administration(s) at 18-30 day intervals, and 2 to 7 such cycles are preferably applied. Additionally, the combination treatment with FK228 and retinoic acid (preferably all-trans-
15 retinoic acid: ATRA) is also preferable.

The present invention is described in more detail in the following by way of Examples. The present invention is not limited in any way by these Examples.

Example 1: antitumor effect of FK228 on human renal tumor
20 xenograft

(1) Preparation of drug

A recommended amount of FR901228 was weighed, a solvent (10% HCO-60 (Nihon Surfactant Kogyo K.K./saline) was added and the mixture was ultrasonicated for dissolution. The positive
25 control substance, Taxol, was dissolved in Cremophor EL (SIGMA/ethanol (1:1)) to a concentration of 24 mg/mL before test and preserved in refrigerator. When in use, a 9-fold amount of physiological saline was added to dilute the substance to 2.4 mg/mL (solvent component: 5% Cremophor EL-5%
30 ethanol-90% saline).

(2) Animals

For the antitumor activity test of the drug, BALB/cANnNCrj-nu/nu mice (female, 6-week-old) were purchased from Charles River Japan (Yokohama, Japan), and after

acclimation for more than 1 week, subjected to the test. The mice were reared in an SPF environment, where free access to water and feed was allowed.

(3) Tumor

5 2-3×10⁷ Human renal tumor (RXF-631L: Cancer Chemotherapy Center, Japan Foundation for Cancer Research, Tokyo, Japan) was maintained subcutaneously by serial passage in BALB/cANnNCrj-nu/nu mice.

(4) Experimental implantation and grouping

10 Fragments (3×3×3 mm) of RXF-631L tumor were subcutaneously implanted into the right flank of BALB/cANnNCrj-nu/nu mice. When the tumor volume reached 100-300 mm³ after the tumor implantation, the mice were grouped (6 per group) avoiding dispersion in the tumor volume. The tumor volume was
15 calculated from the formula: tumor volume (mm³) = 1/2×L×W² where L and W represent the length and width of the tumor mass, respectively.

(5) Administration

 The administration was started on the day the mice were
20 grouped (Day 0). FR901228 (3.2 and 1.8 mg/kg) was intravenously administered to the FR901228 administration group 3 times every 4 days (q4d×3). The positive control substance, Taxol, was intravenously administered (24 mg/kg) to the Taxol administration group for 5 consecutive days (qd×5). The
25 solvent alone (10% HCO-60/saline) was administered to the control group (q4d×3). The liquid amount of administration was calculated based on the body weight measured on the day of administration (0.1 mL/10 g body weight). The MTD (maximum tolerance dose) of FR901228 and Taxol was 3.2 mg/kg/day (q4d×3)
30 and 24 mg/kg/day (qd×5), respectively.

(6) Measurement of tumor size and body weight

 The tumor size (length, width) and body weight were measured twice a week from Day 0.

 The results are shown in Fig. 1, wherein -●- shows a

shift in the size of tumor in the control group, -■- shows that by the administration of 1.8 mg/kg of FR901228, -▲- shows that by the administration of 3.2 mg/kg of FR901228 and -◆- shows that by the administration of 24 mg/kg of Taxol.

5 FR901228 suppressed the growth of human kidney cancer *in vivo*.

Example 2: Antineoplastic response

One patient (Patient Number 31-00-83-2) demonstrated a partial response. This patient was a 38-years-old female with a history of clear cell renal carcinoma that was diagnosed in
10 1996. The patient received a total of 10 doses of FR901228: FR901228 was administered at 9.10 mg/m² on day 1 and day 5 of the first cycle (21 days), 9.10 mg/m² on day 1 of the second cycle (21 days), 9.10 mg/m² on day 1 and day 5 of the third cycle (28 days), 9.10 mg/m² on day 1 of the fourth cycle (22
15 days), 12.70 mg/m² on day 1 of the fifth cycle (20 days), 17.8 mg/m² on day 1 of the sixth cycle (23 days), 17.8 mg/m² on day 1 of the seventh cycle (23 days) and 17.8 mg/m² on day 1 of the eighth cycle (21 days) by continuous infusion for 4 hours. The treatment effect was evaluated based on the RECIST criteria.
20 This patient experienced a partial response after the first two cycles and disease progression was noted after cycle 8.

Industrial Applicability

The therapeutic agent of kidney cancer of the present invention comprising FK228 (particularly FR901228) or a salt
25 thereof, having a histone deacetylase inhibitory activity, as an active ingredient shows a superior antitumor activity not only *in vitro* but also *in vivo*. The therapeutic agent of kidney cancer of the present invention shows a superior antitumor activity in human patients with kidney cancer.
30 Therefore, the present invention can be suitably applied for the treatment of kidney cancer.

Free-text of Sequence Listing

SEQ ID NO: 1: Xaa is an amino acid represented by the formula NH₂C(CHCH₃)COOH. In the formula COOHCH₂CH(CHCHC₂H₄SH)OH, the

carboxylic group is bonded with the amino group of the first amino acid Val, the hydroxyl group is bonded with the carboxylic group of the fourth amino acid Val, and the SH group is bonded with the SH group of the second amino acid Cys via a
5 disulfide bond.

This application is based on a patent application No. 60/369,868 filed in U.S., the contents of which are hereby incorporated by reference.

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